CUTEC News

2014 SUMMER FESTIVAL PROGRAMME

EDITORIAL

FUEL CELLS – DEAD-END OR 'SILVER BULLET' TECHNOLOGY?

Dear Reader,

the principle of the fuel cell is certainly not a new one. It was discovered by Christian Friedrich Schönbein and Sir William Grove more than 170 years ago. Fuel cells have long been considered a 'silver bullet' technology capable of solving the urgent problem of future energy supply at a stroke. Yet in spite of some massive development expenditure, no really successful market penetration has been achieved. As a result, fuel cells have become seen as a solution 'on-hold' – embodying major technical potential, but continually delayed in terms of market implementation. Following the hype at the start of the new millennium, little has been heard about fuel cells for quite some time.

Largely unnoticed by the general public, however, the so-called "valley of death" prior to market launch has indeed been overcome thanks to sustained R&D work on the part of both industry and research institutions: Fuel cell-based power generators for mobile homes have been selling successfully for a number of years. And the technology is also expected to become established soon in the mass market for combined heat and power generation for the private sector. As part of the large-scale CALLUX practical trial, almost 400 fuel cell heaters have been undergoing testing under real conditions in Germany since 2009. In 2.9 million hours in operation, the combined heat and power plants have generated more than 1.7 million kilowatt-hours of electricity in a highly efficient manner from low-carbon natural gas. The carbon dioxide emissions of the households taking part decreased by around a third compared to a condensing boiler and electricity from the grid. In Japan, some 40,000 households are already equipped with fuel cell systems for the distributed generation of power and heat. The USA and South Korea are running fuel cell plants with several hundred MW of installed power, and small-lot production of fuel cell powered vehicles is starting this year in Asia.

Continuity in research and development is key to the advancement of innovative and risky technologies through to technical maturity and subsequent market launch. That also means continuity in funding of research and in maintaining the necessary market conditions to provide industry and scientific bodies with a sound basis for their development work, enabling them especially to bridge the inevitable gaps in the necessary advances.

The fact that continuity can lead to success is also illustrated by the fuel cell-related activities of CUTEC. After over 10 years of successful project work, publications, contributions to scientific bodies and showing at trade fairs and exhibitions, CUTEC has become a nationally and internationally established player in the development of fuel cell systems. This is demonstrated by the organisation's stable in-flow of contract work, both from industry and through publicly funded projects, including now at EU level.

If you want to see for yourself what wide variety of fuel cell-related issues and solutions are being worked on at CUTEC, why not come and visit us for a system demonstration. We look forward to seeing you!

Best regards,

Andreas Lindermeir
Head of the Department of Chemical Power Systems

CUTEC SUMMER FESTIVAL

You are cordially invited to this year's CUTEC Institute Summer Festival:

on Thursday, June 12, 2014, starting at 3 p.m.

The event will also include a series of brief presentations on some of the CUTEC Institute's key areas of current and future research and development work.

PROGRAMME

3 P.M. **COFFEE AND CAKES**

3.30 P.M. **WELCOME AND OPENING**

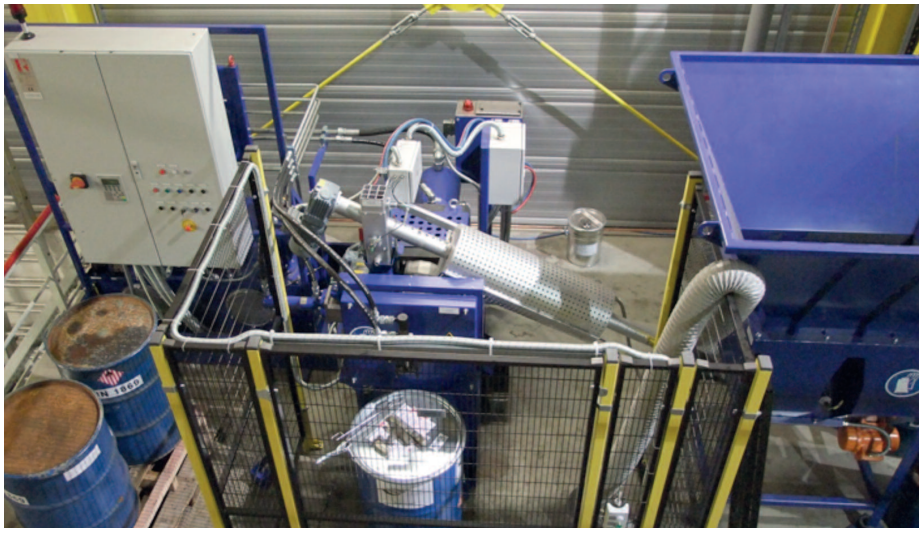
3.40 P.M. **SUMMER COLLOQUIUM ON CURRENT ENERGY POLICY QUESTIONS**

4.30 P.M. **TOUR OF THE INSTITUTE**

5 P.M. **SUMMER FESTIVAL WITH FOOD AND DRINKS**

We look forward to seeing you at the event!

RESOURCE EFFICIENCY IN USE OF THE HIGH-TECH METAL MAGNESIUM



Chips converter (by Rauch Fertigungstechnik GmbH, Austria) at CUTEC

HOVEMAS is the German acronym for a project that uses „innovative methods for high quality recycling of magnesium chips". The German Federal Ministry of Education and Research" (BMBF) is funding this joint project in its "KMU-innovativ" programme (a platform for innovative small and medium-sized enterprises (SMEs or, in German, "KMUs")). Represented in this network are research (Institute of Metallurgy, IMET, at Clausthal University of Technology) and industry (SKW Stahl-Metallurgie GmbH, Magrec Recycling GmbH, Fritz Winter Eisengießerei GmbH & Co. KG) with CUTEC and its metal recycling department as coordinator. Thus, results and new ideas can be developed from lab scale to pilot plant dimensions.

Strands from magnesium chips compressed at 430°C

The challenge in this project on the one hand is the infinite variety of possible magnesium chips. They arise, for example, by the machining of magnesium pressure die castings. Those pressure die castings may well consist of different alloys. This results in mixtures of alloy chips that can hardly be sorted in their pure alloy form. On the other hand, these chips are often contaminated with cutting fluids or oils. These impurities are neutralized by purification means for example with lime. However, this brings with it a new and different impurity. Depending on the subsequent process, these impurities can even prove to be beneficial. There are again many ways to customize these cleaned magnesium chips to individual industrial requirements.

In CUTEC magnesium alloy chips are processed for example with a chips converter. This chips converter – constructed by Rauch Fertigungstechnik GmbH, Austria – compresses magnesium chips in a hydraulic extruder with temperatures up to 600 °C. At this temperature chips with high magnesium contents soften plastically and can be compacted to high densities, as the melting point of pure magnesium is about 649 °C. These so produced strands have several advantages compared to the chips. Through compaction the surface area decreases which makes it safer to transport and store. Also the volume is reduced by compaction to less than 33 % of the original volume (bulk density chips <0.5 g/cm³; strand density >1.5 g/cm³). Secondly these strands of compacted chips should be easier to remelt in magnesium alloys according to the high density and low surface area, which means less oxidising. Furthermore there is the idea to machine these sintered strands to gain chips of specific shapes and sizes so they are better suited for subsequent processes and their associated ways of transport.

The chips converter – as most other industrial processes – needs a certain chip size to be able to work with. So there arises the question of what to do with finer magnesium material. To be able to test free-flowing properties and combustion behaviour an artificial fine fraction was produced by grinding of existing chips at CUTEC. Depending on the composition of the magnesium alloy chips the fine fraction can be utilised, for example, for cored wires which are used in desulphurisation of ferrous melts.

Molten iron waiting to set the sulphur content by using magnesium cored wire

The combination of lab scale basic research (IMET), pilot plant scale (CUTEC) and industry (e.g. Fritz Winter) ensures that research matches the needs of the industry. It is possible to respond individually and quickly to newly obtained results in research, or new request from industry partners so the research objectives can be adjusted accordingly. Thus, a promising course of the project is guaranteed. (ditt)

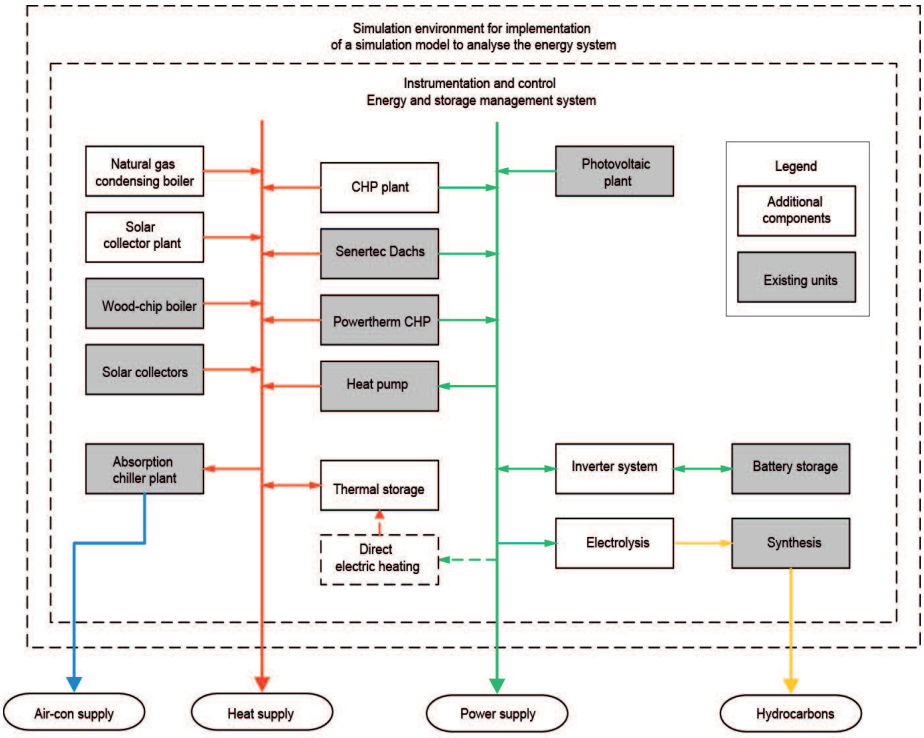
ERECTION OF A MODEL SYSTEM FOR ANALYSIS OF THE ENERGY SYSTEM WITH SYSTEM INTEGRATION OF RENEWABLE AND DISTRIBUTED ENERGY SOURCES

In mid-December 2013, the Lower Saxony State Ministry of Science and Culture approved a project submission relating to the construction of a model system for analysis of the energy system with system integration of renewable and distributed energy sources. The project, named "Modellsystem Energie", or Model Energy System, for short, is being financed by resources from the Lower Saxonian Ministry of Science and Culture. The resource contribution relates to the appointment of Professor Faulstich to the Chair of Environmental and Energy Technology at the Technical University of Clausthal. Additional personnel resources for scientific staff are also being provided.

The aim of the project is to construct and operate a comprehensive simulation model for combined energy systems capable of validation in a real trial environment. The selected model system energy comprises of a wide variety of distributed and renewable energy sources, providing electric power, heat and mobility, and including the option of material usage. It also incorporates storage facilities for electrical, thermal and, where appropriate, material energy forms.

The overall project is divided into several phases. In the first phase, additional units will be procured and set up to complement the combined energy system. The units concerned are a natural gas-powered condensing boiler, a large thermo-solar plant and an innovative combined heat and power (CHP) plant. These components will supplement the existing infrastructure of the Energy Park Clausthal (see illustration above). For subsequent simulation and potential optimisation of the overall system, the relevant measurement instrumentation and data interfaces to the existing and new components will be set up and run.

Latent heat storage as an innovative element in future energy systems



Existing units and additional components in the Model System Energy

In the second phase, the various storage technologies will be integrated into the infrastructure. A latent heat storage facility has already been procured.

It will be operated in conjunction with the thermal power generation systems as part of CUTEC's aim of optimising consumption (see illustration below). The subsequent steps involve constructing electricity storage systems and linkage with the research projects relating to the generation of synthetic hydrocarbons.

For the final phase, all components will be operationally connected to the simulation environment. The simulation process will validate the intended combining strategies and optimise the overall system, taking into account the selected (and where appropriate changeable) conditions, such as the seasons; storage conditions; interaction of the storage systems; fluctuating supply; use of CHP, etc.

The challenge for a future energy system lies in optimising the production, storage, consumption and possible conversion of the various energy forms in combination. In other words: to attain a high degree of flexibility in serving the consumption sectors for power and heat, including air-conditioning output and mobility needs. This can be achieved if the individual, increasingly renewables-based, energy sources can be deployed ideally in direct form, and where necessary or in case of surplus can be converted or stored as appropriate. The current buzz-words in this context are "Power-to-Gas" and "Power-to-Heat": that is, the conversion of surplus power from wind energy and photovoltaic into natural gas or heat. Those solutions are good to aim for, but CUTEC is looking to go further and undertake an even more comprehensive analysis of future energy systems. The construction of the model energy system creates the basis for that, as it enables a wide variability of research both experimentally and by simulation. It opens up promising opportunities for new research approaches, as well as establishing excellent conditions for education and training. (sie)

HIGH-RANKING APPOINTEES ONCE AGAIN: SCIENTIFIC ADVISORY BOARD OF THE CUTEC INSTITUTE

In recent weeks the CUTEC Institute has approached a number of leading personalities from various areas of society to become members of its new Scientific Advisory Board. We are pleased to report that all those approached took up the invitation.

CUTEC Managing Director Professor Faulstich emphasises the importance of the Board, which plays a key role in determining the future scientific work and strategy of the organisation. It also provides an outstanding platform for the development of new and attractive fields of business and research, as well as for strengthening business links, thereby aiding efforts to create a "sustainable industrial society" and to build further upon the leading position of the CUTEC Institute.

Professor Faulstich would also like to take this opportunity to thank the members of the current Board most sincerely for their efforts, and to express his admiration for their valuable work. In the scientific field, his thanks go to Professors Heinzel (ZBT Duisburg), Calmano (TU Hamburg-Harburg), Grünewald (Ruhr University Bochum) and Horn (KIT). His thanks likewise go to the representatives of industry who have served on the Board, namely Dr. Buddenberg (EWE AG, Oldenburg), Dr. Gohlke (Alstom Power GmbH, Stuttgart), Dr. Mayer (BMA AG, Braunschweig) and Dr. Wullbrandt (Nordzucker AG, Braunschweig) as well as to his academic colleagues from Clausthal, Professors Bohn, Schwarze, Turek and Weber and, in particular, to the former Chairman of the Scientific Advisory Board, Professor Wesling.

The CUTEC Institute is intent on sustaining its success. The Scientific Advisory Board, tasked to advise and support the institute in its research and development activities, will in future comprise 15 members. The diversity of topics is sure to grow continually in terms of information, resources and energy, becoming ever more interdisciplinary in nature and increasing in complexity. The Scientific Advisory Board will provide valuable input to future discussions on those questions. CUTEC looks forward to enjoying constructive and fruitful collaboration with the Board.

The members of the newly constituted Scientific Advisory Board are as follows:

Four colleagues from the Technical University of Clausthal, who have long been linked to the CUTEC Institute, will be on hand to provide advice and support locally:

- Prof. Hans-Peter Beck,
- Prof. Daniel Goldmann,
- Prof. Volker Wesling – mit
- Prof. Andreas Rausch

Prof. Rausch is a new member who will be joining the Board. As the current Vice-President of the Technical University of Clausthal, he will in future also assume the role of Chairman of the Scientific Advisory Board.

The field of research institutions will in future be split into three organisational categories: Other universities; non-university research institutions; and scientific and professional bodies. The following experts from those fields will sit on the Scientific Advisory Board:

- Prof. Michael H. Breitner, Leibniz University Hanover
- Prof. Rolf Brendel, Institut für Solarenergieforschung GmbH, Hameln
- Prof. Norbert Dichtl, Technical University of Braunschweig
- Prof. Jutta Geldermann, University of Göttingen
- Prof. Christa Liedtke, Wuppertal Institut für Klima, Umwelt, Energie GmbH
- Dr. Volker Steinbach, Federal Institute for Geosciences and Natural Resources, Hanover
- Petra Wassmann, Naturschutzverbund Deutschland e.V., Salzgitter

In view of its role as a link between industry and science, it is particularly important for CUTEC that its work should be highly practice-oriented. CUTEC will in future engage in direct dialogue with the following experts from the industrial sphere:

- Dr. Michael Fooken, H.C. Starck GmbH, Goslar
- Karl-Heinz Müller, EEW Energy from Waste GmbH, Helmstedt
- Dr. Andreas Sieverdingbeck, Recylex GmbH, Goslar
- Dr. Peter F. Tropschuh, Audi AG, Ingolstadt

The certificates of appointment from the Lower Saxony State Ministry of Science and Culture have already been sent to the experts concerned. The constituting meeting is scheduled for the Summer. According to its statutes, the Scientific Advisory Board is composed of 15 members. It meets twice a year.

Starting in the next issue of CUTEC News, we will be presenting profiles of the new members, as well as reporting on their expectations relating to their new role, and what functional interfaces exist.

Scientific Advisory Board of the CUTEC Institute

MATERIAL FLOWS IN THE ANTHROPOCENE ERA – CHALLENGES, OPPORTUNITIES AND PROSPECTS FOR ELECTRONIC SCRAP AS A RESOURCE

The Institute for Advanced Sustainability Studies (IASS, Potsdam; Executive Director Prof. Klaus Töpfer) and the CUTEC Institute are developing an interdisciplinary Graduate Network together with partners from the fields of science, industry and politics as well as from relevant industry bodies relating to electronic scrap and secondary raw materials. It aims to investigate questions relating to the safeguarding of existing deposits of strategic elements based on recovery from secondary raw material sources, the collection of end-of-life equipment, and the relevant legal and political conditions, as well as options for new business models, all along the ICT (information and communications technology) product value chain.

In establishing an inter-university Graduate Network, the Institute is pursuing a new-style research approach intended not only to generate valuable results and sources of discussion for up-and-coming scientists and stakeholders in society at large, but to build a pilot model for innovative, interdisciplinary and creative science. A launch with the WEEE (Waste Electrical and Electronic Equipment) Mining Graduate Network is planned starting in mid-2014.

The use of resources and recycling of materials in the Anthropocene era is gaining in importance in view of global demographic trends, increasing competition for available and financially affordable raw materials, and massive ecological challenges. This is particularly true with regard to metals used in technology applications such as gallium, germanium, indium, palladium, platinum and tantalum. The EU economy, which has few such raw materials at its disposal, will in future be increasingly reliant on recycled end-of-life materials, which have to date not been furnished in sufficient volumes. ICT products, in particular, are ideal objects for research: Thanks to the ubiquitous nature of products such as mobile phones, televisions and computers, patterns of usage and consumption are easy to analyse. ICT products contain large numbers of technological metals, and based on their short life-cycles and very high volumes they entail high levels of resource input. The WEEE Mining Graduate Network is headed by Dr. Mario Tobias, Dr. Andreas Bühn and Prof. Martin Faulstich. (bü)

Partners

NEWS FROM THE CUTEC TEAM

The Department of Metal Recycling will in future be assisted in its challenging project work by two new scientists.

Thore Stein, M. Sc.

Thore Stein began working at the CUTEC Institute on December 1, 2013.

Mr. Stein obtained a Bachelor of Science in agricultural ciences from the University of Bonn. He then very successfully completed a Masters degree in Management of Natural Resources at the Martin Luther University of Halle-Wittenberg.

Within the Department of Metal Recycling, he will be working as a scientific staff member and doctoral candidate on the BMBF-sponsored "ROBEHA" project relating to the sustainable use of the raw material potential from mine slag-heaps in the Harz mountains for the supply of strategically key industrial metals from anthropogenic deposits.

Dipl.-Umweltw. Jan Lutz Schlecht

Jan Lutz Schlecht joined the CUTEC Institute's Department of Metal Recycling as a scientific staff member and doctoral candidate on October 1, 2013.

Mr. Schlecht studied at the University of Valencia in Spain, where he gained a degree in environmental sciences (Licenciatura en Ciencias Ambientales).

During his studies, he took part in the European Union's ERASMUS programme, as part of which he spent time at the Johannes Gutenberg University in Mainz. At the CUTEC Institute he is working on industrial contracts, particularly in the field of WEEE mining, aimed at enhancing resource efficiency by means of metal recycling – a successful field of business for the Institute. (wes)

After three-and-a-half years in training at the CUTEC Institute's mechanical workshop, Adrian Wahlert from Clausthal has passed his final examination to become a qualified industrial mechanic. Head of the Institute's mechanical workshop Ralf Bauer comments proudly: "Mr. Wahlert is the fourth trainee whom we have successfully qualified as an industrial mechanic." Industrial mechanics assemble, maintain and monitor technical systems.

The CUTEC Institute has been providing training since 2005, not only in its mechanical workshop but also in its electrical workshop, administrative functions and analytics department. (he)

REPRESENTING CUTEC

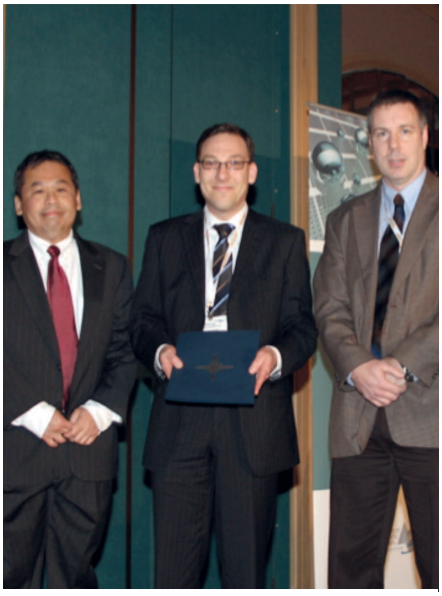
IFAT MEDIA DIALOGUE IN MUNICH

The Messe München trade fair organisation this year began early with its efforts to promote IFAT, considered the lead event in the field of water, sewage, waste and raw materials management, which is scheduled for May 2014. The first-ever IFAT Media Dialogue held at the start of the year brought together exhibitors and media representatives. A number of new products and emerging trends in the environmental technology sector were presented to a gathering of 80 journalists, including some 50 from outside of Germany. This provided the exhibitors with the opportunity to rehearse their showing in May and to profile their businesses and the technological advances made in dialogue with an international media audience.

Also as part of the IFAT Media Dialogue event, on January 7, 2014 an expert's forum was held on the subject of "Water and waste management in Eastern Europe – Opportunities for SMEs". Leading industry figures, including Vojtěch Doležal, Managing Director of a Czech consultancy for large-scale projects; Michael Ludden, Managing Director of Sutco Recycling Technik GmbH & Co. KG; Hans G. Huber (†), Chairman of the Supervisory Board of Huber SE; Martin Faulstich, Managing Director of the CUTEC Institute and SRU Chairman; and Wolf-Dietrich Müller from Messe München International, discussed the opportunities, risks and obstacles linked to expansion into the growth market of Eastern Europe. Issues such as bureaucracy and legislation, local manpower, sales of large-scale plants as well as corruption were on the agenda. The wealth of associated topics could have been discussed at much greater length than the limited time available. (ro)

Prof. Faulstich answers questions from the audience

DR. LINDERMEIR RECEIVES "BEST PAPER AWARD" IN USA



Andreas Lindermeir (centre) with ECD Chairman Sujanto Widjaja (left) and ECD Program Committee Chairman Michael J. Halbig (right) at the award ceremony

On the occasion of the 38th International Conference on Advanced Ceramics and Composites in Daytona Beach, Florida, USA, Andreas Lindermeir was awarded with the Best Paper Award by the Engineering Ceramics Division (ECD) of the American Ceramic Society (ACerS).

The first prize, from among some 800 conference contributions, was granted to Andreas Lindermeir, Ralph-Uwe Dietrich and Jana Oelze for their paper "SOFC System for High Efficiency Power Generation from Biogas", which was presented at last year's conference. Dr. Lindermeir returned to Daytona Beach to receive the award in person during the plenary session on behalf of the authors.

The ECD Best Paper Award is presented from among all the papers submitted for the annual conference. Criteria include originality, technical/scientific quality, and significance for ceramics research. The award to the CUTEC team marked the first time that the jurors had chosen a paper from the SOFC field – and one which was also highly application-oriented. (li)

"RAW MATERIAL EFFICIENCY AND INNOVATION" SYMPOSIUM IN NUREMBERG

The Fraunhofer Institute for Chemical Technology hosted its third symposium in Nuremberg on February 5th and 6th of this year. Representatives from the CUTEC Institute in attendance were Prof. Martin Faulstich, Dr. Nina Roth and Mr. Thore Stein.

The event formed part of the programme of scientific and technical exchange on the subject of raw material efficiency and optimisation. A wide range of speakers from the fields of industry, science and politics provided the attentive audience with detailed insights into new technology trends, implemented technologies, funding possibilities and economic prospects for innovative products and processes.

The auditorium

The first day featured an overview of the political framework and planned research funding measures, as well as surveying the economic situation particularly with regard to raw materials for iron and steel production and the associated high-tech fields. The focus of the second day was on interesting and innovative "small-scale" processes. Numerous means of optimising existing methods and techniques were profiled and new, exciting technologies were presented.

A particular highlight of the event was the splendid "Franconian evening", featuring a buffet of local specialities accompanied by tasty Franconian beer. The evening provided a relaxing setting for making new contacts and linking up again with old friends. (st)

SUCCESSFUL CONCLUSION OF THE LOWER SAXONY SOFC RESEARCH ASSOCIATION

The participants of the event

CUTEC has for a number of years being investigating various systemic approaches as the foundation for the industrial development of marketable, high-efficiency power generation systems based on SOFC.

Based on the experience gathered to date, in March 2010 a Lower Saxon-research association was established to bring together the relevant players from the fields of research and industry around the state (see CUTEC News 27 from May 2010).

In the just over three years projectduration, the participating organisations – departments of the Universities of Braunschweig, Hanover and Clausthal, the Fachhochschule Osnabrück and the CUTEC Institute – have succeeded in constructing an SOFC system for the low power range (300 W_e) which features a number of innovations above and beyond the existing state of the art:

- Compact, planar design and stacked layout of the main components, largely eliminating the need for pipework
- Self-developed reciprocating piston compressor for anodic exhaust gas recirculation
- Combined sandwich-type reformer-burner reactor
- Innovative stack clamping fixture with monitoring and active control of clamping force
- Efficient thermal insulation by means of internal air flushing
- Designed and built using industry-standard fabrication, joining and assembly techniques (laser welding/cutting; EDM)
- Lower intrinsic electricity consumption thanks to reduced use of sensors and actuators
- Significant increase in electrical efficiency thanks to intrinsic use of waste heat for endothermic reforming and to preheat the air and combustion gas

The complete system was operated with a stack output of 550 W_e, corresponding to a gross efficiency of η_{el} = 45.8 %. After deducting the internal consumption, this corresponds to a net electrical efficiency of > 35 %.

Industrial partners are now being sought to enhance and commercialise the SOFC research results, and consideration is also being given to the procurement of venture capital.

We would like to take this opportunity to express our thanks to the industrial project partners EcoEnergy GmbH (Walkenried), Elster GmbH (Osnabrück), EWE AG (Oldenburg), GEA Ecoflex GmbH (Sarstedt), H.C. Starck GmbH (Goslar), LASER on demand GmbH (Burgwedel), SIEB & MEYER AG (Lüneburg), Solvis GmbH & Co KG (Braunschweig) and stack supplier sunfire GmbH (Dresden) for their generous support to the project. (di)

DIARY

- Summer Festival at the CUTEC Institute on June 12, 2014, starting at 3 p.m.
- 7th State of Lower Saxony Fuel Cell Summer School, September, 15 to 19, 2014 Technical University of Brunswick

IMPRINT

Published by:
CUTEC Institut
Contributors:
Dr. A. Bühn, IASS, Potsdam (bü)
Dr.-Ing. R.-U. Dietrich (di)
Dipl.-Ing. A. Dittmar (ditt)
Dr. T. Heere (he)
Dr.-Ing. B. Kragert (kra)
Dr.-Ing. A. Lindermeir (li)
Dr. N. Roth (ro)
Dipl.-Ing. W. Siemers (sie)
T. Stein, M. Sc. (st)
Layout and setting:
G. Wessels (wes)
Production and supply:
CUTEC Institut
Leibnizstr. 21
38678 Clausthal-Zellerfeld
Tel. 05323 933-0
Fax 05323 933-100
E-Mail: cutec@cutec.de
Internet: www.cutec.de
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Send an E-mail to:
cutec-news@cutec.de